2. *Occultation of Sept.* 28.

	Disappearance.		Reappearance.	
	h m	°	h m	°
Greenwich	20 33·0	132	21 19·3	234
Edinburgh	20 30·6	147	21 7·2	221
Liverpool	20 30·4	137	21 14·6	230
Dublin	20 27·8	135	21 14·4	232

The above are Greenwich mean times at the respective observatories.

Elliptic Elements of Comet II. 1883 (*Ross*). By Robert Bryant, B.A.

Having seen published as yet no discussion of all the observations of this comet, the reduction of the same was undertaken, and the results below are communicated, as they may be not without interest to the Society.

The reason for no complete determination of the elements having been made is perhaps due to the scant material upon which to work, and to the fact that few as the observations are, they do not in general show that agreement with an ephemeris computed from approximate elements which they should do.

From the mean of two sets of approximate parabolic elements an ephemeris was computed, extending from a few days before the first observation of the comet to a few days after it ceased to be visible, and as this ephemeris was originally intended to form the basis of the subsequent determination of the elements, it was computed with the greatest care for alternate days in order to reduce the possibility of error in the interpolation. This was interpolated with fourth and sometimes fifth differences, and the results when corrected for parallax were compared with all the published observations of the comet. Many of the observations then showed far greater and irregular discordances than could be attributed to errors of computation.

On the suggestion, therefore, of Dr. Hind (to whom my thanks are due for the assistance rendered in this and in work of a kindred nature) it was resolved to obtain the elements from Tebbutt's observations alone, which presented almost uniform discordance when compared with the ephemeris.

To this end a parabola was computed passing through the places of his extreme observations, and comparison was made with a middle place. It was found that although an agreement might be forced between the extreme observations and one coordinate of the middle place, yet the remaining coordinate exhibited a large error. It was, therefore, determined to obtain elements with an eccentricity different from unity, and to pass to these by means of differential equations.

The first corrections to the approximate elements were of such magnitude as to scarcely justify the assumption that the squares and higher powers of the differentials might be neglected. Consequently, fresh coefficients were calculated and a redetermination of the differentials made, the results of which are given below.

The elements from which the ephemeris was computed in the first instance are

T	1883, Dec. $25^d{\cdot}30154$ G.M.T.	
ω'	$113^\circ\ 36'\ 50''{\cdot}5$	Mean Equator 1884·0
Ω'	$254\ 33\ 46{\cdot}1$	
i'	$110\ 37\ 51{\cdot}1$	
$\log q$	9·490993	

Comparison was made with the following three places observed by Tebbutt at Windsor, N.S.W.

Windsor M.T.		R.A.	Decl.
	d h m s	h m s	° ′ ″
1884, Jan.	19 9 37 42	22 54 35·62	−41 46 56·3
	19 9 37 42	22 54 35·53	−41 46 56·5
	25 9 14 35	23 22 33·60	−41 59 19·6
	25 9 14 35	23 22 33·79	−41 59 18·7
Feb.	2 9 38 9	23 48 47·64	−41 44 19·1

the mean of each double observation being taken.

The respective corrections to two sets of elements gave the following approximate elliptic elements :—

T	...	1883, Dec. $25^d{\cdot}139019$ G.M.T.		1883, Dec. $25^d{\cdot}137890$ G.M.T.	
ω'	...	$112^\circ\ 43'\ 47''{\cdot}01$	Mean Equator 1884·0	$112^\circ\ 43'\ 34''{\cdot}65$	Mean Equator 1884·0
Ω'	...	$254\ 29\ 51{\cdot}25$		$254\ 30\ 35{\cdot}61$	
i'	...	$110\ 21\ 18{\cdot}98$		$110\ 21\ 22{\cdot}05$	
$\log q$	...	9·4885050		9·4886041	
e	...	0·9855308		0·9851042	

These give the following residuals for the three observations above (obs.-comp.).

I.	$d\alpha \cos\delta$	$+8''{\cdot}53$	$+10''{\cdot}51$	$+13''{\cdot}39$
	$d\delta$	−1·64	− 1·65	− 0·67
II.	$d\alpha \cos\delta$	+13·72	+14·88	+19·06
	$d\delta$	− 0·35	− 0·99	− 1·72

From the first of the above sets of elements a new set of differential coefficients was derived and the following equations

were obtained, the first and second independent terms in each equation referring respectively to the residuals in the three places derived from the first and second set of elements :—

$8{\cdot}03449_n d\mathrm{T} + 9{\cdot}70595 de + 9{\cdot}99668 d\log q + 9{\cdot}73417_n d\Lambda' + 9{\cdot}58974_n \sin i' d\Omega' + 7{\cdot}88138 di$					$= 1{\cdot}09528,$ $1{\cdot}30202$
$8{\cdot}22898$	$8{\cdot}61768_n$	$9{\cdot}92744$	$9{\cdot}58653_n$	$0{\cdot}00377_n$	$9{\cdot}68413$
				$= 0{\cdot}37953_n,$	$9{\cdot}70874$
$7{\cdot}74293$	$9{\cdot}77043$	$0{\cdot}04388$	$9{\cdot}82666_n$	$9{\cdot}59120_n$	$8{\cdot}81171_n$
				$= 1{\cdot}18531,$	$1{\cdot}33639$
$8{\cdot}11376$	$7{\cdot}75546_n$	$9{\cdot}91114$	$9{\cdot}60366_n$	$9{\cdot}97886_n$	$9{\cdot}75593$
				$= 0{\cdot}38120_n,$	$0{\cdot}15935$
$7{\cdot}28605_n$	$9{\cdot}82430$	$0{\cdot}05673$	$9{\cdot}88482_n$	$9{\cdot}59477_n$	$9{\cdot}17915_n$
				$= 1{\cdot}28810,$	$1{\cdot}44145$
$8{\cdot}00727$	$8{\cdot}49576$	$9{\cdot}89973$	$9{\cdot}63295_n$	$9{\cdot}94917_n$	$9{\cdot}80384$
				$= 9{\cdot}98727_n,$	$0{\cdot}39675$

where $d\Lambda' = d\omega' - d\Omega'$.

The differentials of T, q, and e are expressed in parts of the radius as unity.

In these equations the addition and subtraction was performed by logarithms and checked by natural numbers.

Finally, all the unknowns were substituted in the last of the equations, the agreements between the true and computed values of the independent terms showing that the solution had been correctly performed.

The following are the values of the differentials :—

$d\mathrm{T}$	$-0{\cdot}013386,$	$-0{\cdot}004733$
$d \log q$	$-0{\cdot}0002293,$	$-0{\cdot}0002422$
de	$-0{\cdot}0012183,$	$+0{\cdot}0000121$
$d\Lambda'$	$-287''{\cdot}49,$	$-67''{\cdot}07$
$d\Omega'$	$-\ 5'{\cdot}45,$	$-59'{\cdot}79$
di'	$-\ 87'{\cdot}14,$	$-49'{\cdot}73$

and thus the following elements are obtained :—

T	...	1883, Dec. $25^{d}{\cdot}125633$ G.M.T.	1883, Dec. $25^{d}{\cdot}133157$ G.M.T.
ω'	...	$112^\circ\ 38'\ 54''{\cdot}07$	$112^\circ\ 41'\ 27''{\cdot}79$
Ω'	...	$254\ 29\ 45{\cdot}80$	$254\ 29\ 35{\cdot}82$
i'	...	$110\ 19\ 51{\cdot}84$	$110\ 20\ 32{\cdot}32$
$\log q$	...	$9{\cdot}4882757$	$9{\cdot}4883619$
e	...	$0{\cdot}9843125$	$0{\cdot}9851163$
P	...	86·915 sid. years	94·075 sid. years

These elements do not exhibit *inter se* that agreement which

one might expect, considering that they are both derived from the same observations. They are presented, however, simply as the results of computation, and may serve to illustrate the difficulty of determining the orbit from the data.

The following residuals show how closely each set of elements represents the observed places (obs.-comp.) :—

I.	$d\alpha \cos\delta$	+0".86	+0".11	+0".07
	$d\delta$	+0.19	+0.08	−0.81
II.	$d\alpha \cos\delta$	+0.25	+0.07	+0.24
	$d\delta$	−0.12	0.00	−0.07

An inspection of the observed places shows at once that these residuals are far within the errors of observation.

These elements referred to the ecliptic are

T	1883, Dec. 25^d·625633 Univ. Time*	1883, Dec. 25^d·633157 Univ. Time†
ω	137° 37′ 40".49 (Mean Ecliptic 1884·0)	137° 40′ 21".68 (Mean Ecliptic 1884·0)
Ω	264 12 29.31	264 12 38.65
i	114 44 24.00	114 45 4.69
log q	9·4882757	9·4883619
e	0·9843125	0·9851163
P	86·915 sid. years	94·075 sid. years

Throughout the whole computation checks and the method of differences have been employed wherever such were applicable; in default of these the calculation has always been performed in duplicate, and where possible by independent means. Although the agreement between observation and computation is satisfactory, and although the determination of the elements has been made with every possible care (from logarithms to seven places of decimals, and, where the variation was rapid, from eight places in order to get the seventh correct), yet it must be remembered that in addition to the difficulty of making the observations, the results are derived from only three places, that the extreme observations are separated by an interval of only 14 days, and that the included arc of anomaly is only 14°.

My thanks are also due to Professor Oppolzer, of Vienna, for his suggestions in connection with the work.

London: 1885, *June.*

* *i.e.* 1883, Dec. 25^d·125633 G.M.T. in the ancient mode of reckoning.
† *i.e.* 1883, Dec. 25^d·133157 „ „

Reply to Mr. Stone's Paper on Screw Errors as affecting the N.P.D. of the Cape Catalogue for 1880. By David Gill, LL.D., F.R.S., Her Majesty's Astronomer at the Cape of Good Hope.

In the following paper it will be convenient to take up the points raised by Mr. Stone nearly in the order in which he has stated them.

A considerable portion of my paper, which originated the present discussion, was devoted to a proof that errors of considerable magnitude were produced by wear of the screws and not by constraint, as argued by Mr. Stone.

Mr. Stone appears now to have given up that theory, as he does not support it by any further argument; and whilst admitting that wear may take place, he denies that such wear is sufficient to lead to serious errors in the resulting N.P.D.'s.

Here it will be well to define what are to be considered "serious errors" in this discussion.

A Star Catalogue may be judged by various standards.

1st. Merely as a Zone Catalogue, in which the differences of N.P.D. from standard stars are pretty accurately observed, the adopted places of the standard stars being the reference points of each zone. Or,

2nd. The N.P.D.'s may be considered fundamental, that is proper, without the application of any corrections, for discussions of the law and constant of refraction, the determination of precession and the solar motion in space, and for refined investigations on proper motion.

In the former case an error of $0''.5$, due to accidental screw error, cannot be considered "serious." But in the latter case, if even a much smaller error than $0''.5$ is systematically applicable to the observations of a long successive period, then we must regard such error as "serious," because the Cape (1880) Catalogue having been observed in zones of 10° in Declination, all the results of large adjacent portions of the Catalogue will, in such case, be affected systematically by that common error.

From Mr. Stone's expression (p. 140) of the "hope that Mr. Gill will be better advised than to apply empirical corrections to the Cape (1880) Catalogue," it must be understood that Mr. Stone regards the N.P.D.'s of his Catalogue as fundamental, and consequently that criticism belonging to the latter of the two classes above indicated is legitimately applicable to them.

Passing over, for the moment, all questions as to the origin of the screw errors, and appealing directly to facts, as Mr. Stone desires, the matter in discussion is fortunately reduced to a very simple one by the admission of Mr. Stone that "the curve which Mr. Gill has given (representing the errors of the screws) is the